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bq2013HEVM-001 Gas-Gauge IC Evaluation Module

User's Guide

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Introduction

The bq2013H EVM is a complete evaluation system for the bq2013H Gas-Gauge IC for High Discharge Rates. The EVM includes one DM2013H circuit module, a current sense resistor, an EV2200 PC Interface Board for Gas-Gauge Evaluation, a PC serial cable, and Windows-based PC software. The DM2013H circuit module includes one bq2013H IC, five LEDs to display remaining capacity, and all other components onboard necessary to monitor capacity and other critical parameters in NiCd, NiMH, or lead-acid-based battery packs. The DM2013H connects directly across the cells in a battery. With the EV2200 interface board and software, the user can read the bq2013H data registers and evaluate the functions of the bq2013H under different charge and discharge conditions.

1.1 Features

❏ Complete evaluation system for the bq2013H Gas-Gauge IC

❏ PreprogrammedDM2013H module for quick setup

❏ PC software and interface board for easy evaluation

❏ Software allows data logging for system analysis

1.2 Kit Contents

❏ DM2013H preconfigured circuit module

❏ Sense resistor

❏ EV2200 PC interface board

❏ Set of evaluation software disks entitled EV2200-HDQ

❏ PC serial cable

❏ Set of support documentation

1.3 Ordering Information

Table 1–1. Ordering Information

EVM Part Number	Chemistry	Pack Voltage	Capacity
bq2013HEVM–001	NiCd†	14.4 V†	4.5 Ah†

† Can be changed by reprogramming.

DM2013H—bq2013H-Based Circuit Module

The DM2013H circuit module is a complete and compact example solution of a bq2013H circuit for capacity monitoring of NiCd, NiMH, or lead-acid packs. The DM2013H incorporates a bq2013H gas-gauge IC and all other components necessary to accurately monitor and display the capacity of up to 14 nickel or 12 lead-acid cells.

The DM2013H includes five LEDs to display remaining capacity in 20% increments of the programmed capacity. The LEDs are activated with the onboard push-button switch.

Contacts on the DM2013H provide direct connection to the battery stack (BAT+, BAT–), the sense resistor (BAT–, GND), and the serial communications port (HDQ). The system load and charger connect across BAT+ and PACK–.

The ACC input provides an option to enable the LED display with an external (active low) signal, as from a microcontroller.

2.1 Pin Descriptions

P1	HDQ/Serial communications port
P2	DONE/Done input
P3	BAT+/Battery positive/pack positive
P4	ACC/Display activation
P5	RBI/Register backup input
P6	GND/Ground
P7	PACK–/Pack negative
P8	BAT–/Battery negative

2.2 Programming

The DM2013H circuit module is preconfigured for battery pack chemistry, voltage, and pack capacity. The circuit module can be reprogrammed for pack chemistry, voltage, capacity, and other operating parameters via the programming resistors on the board. The resistors are used to set the programming pins to a high (H), low (L), or float (Z) state on initialization. To set a high (H) state for a programming pin requires the pullup resistor; a low (L) state requires the pulldown resistor; and the float (Z) requires no resistors on the programming pin. The shaded area of the tables indicates the bq2013HEVM-001 configuration. See the bq2013H data sheet for a complete description of how the bq2013H is programmed.

2.2.1 Full Capacity

Pins 2 and 3 of the bq2013H determine the full capacity or programmed full count (PFC) of the DM2013H. Resistors R12–R15 set the pins to a high (H), low (L), or float (Z) state during board initialization.

Table 2–1. Full Capacity Programming

PFC Input Settings			
Pin 2	Pin 3	Sense Resistor MΩ	Capacity (Ah)
H	L	10	3.5
Z	Z	10	4.5
Z	H	10	5.5

2.2.2 Self-Discharge Settings for Chemistry

Battery chemistries have different self-discharge rates. Pin 4 of the bq2013H determines the self-discharge factors of the DM2013H. Resistors R17 and R18 set the pin to a high (H), low (L), or float (Z) state during board initialization.

Table 2–2. Self-Discharge Programming

Self-Discharge Setting	
Pin 4	**Chemistry**
H	NiMH
Z	NiCd
L	Lead–acid

Note: Select the self-discharge setting that most closely models the battery pack to be used.

2.2.3 LED Display Mode

The DM2013H 5 onboard LEDs indicate remaining battery capacity in relative mode (20% increments of the learned battery capacity). Pin 5 of the bq2013H determines the LED display mode of the DM2013H. Resistors R19 and R20 set the pin to a high (H), low (L), or float (Z) state during board initialization.

Table 2–3. LED Mode Programming

LED Mode Setting	
Pin 5	**LED Mode**
H	Relative (20% increments of learned capacity)
Z	Relative (20% increments of learned capacity)
L	Absolute (20% increments of programmed capacity)

2.2.4 Charge Efficiency Compensation

The DM2013H is configured to apply no-charge efficiency compensation. Pin 6 of the bq2013H determines the charge efficiency factors of the DM2013H. Resistors R23 and R24 set the pin to a high (H), low (L), or float (Z) state during board initialization.

Table 2–4. Charge Efficiency Programming

Self-Discharge Setting	
Pin 6	**Charge Efficiency**
H	Lowest Efficiency
Z	Highest Efficiency—100% Efficient
L	Medium Efficiency

Note: Select the charge efficiency setting that most closely models the battery pack to be used.

2.2.5 Offset Error Compensation

The DM2013H is configured to apply compensation to correct for −75 µV of offset error. This is the error typically found using the bq2013H on a well-designed PCB. Pin 7 of the bq2013H determines the offset error compensation of the DM2013H. Resistors R3 and R8 set the pin to a high (H), low (L), or float (Z) state during board initialization.

Table 2–5. Charge Efficiency Programming

Self-Discharge Setting	
Pin 7	Offset Compensation
H	−150 µV
Z	−75 µV
L	0 µV

2.2.6 Pack Voltage

The DM2013H is preconfigured for pack voltage (number of cells). R2, R6 and R7 configure this as shown in the schematic and are set as shown in Table 2–6.

Table 2–6. Pack Voltage Programming

EVM Part Number	R2	R18	R19	End-of-Discharge Level 1	End-of-Discharge Level 2
bq2013HEVM-001	1.5 MΩ	1.1 MΩ	100 K	12 V	10.8 V

2.2.7 Programming Hardware Changes

The following procedure changes the configuration of DM2013H to other (un-shaded) options listed in the tables above:

1) Ensure that the DM2013H is disconnected from the battery.

2) Determine the resistors required to achieve the high (H), low (L), or float (Z) states on the program pin inputs.

3) Remove the 200k resistors where needed.

4) Place required 200k resistors where needed.

5) If required, change the voltage programming resistors as outlined on the schematic.

6) Reconnect the DM2013H to the battery pack.

The EV2200 and the PC software can be used to confirm the new settings by reading the PPU and PPD data registers and the Setup screen.

DM2013H Schematic

The DM2013H schematic shows all possible components on the board for various configurations, including all configuration resistors. Only those resistors that set the desired configuration should be installed. The schematic notes indicate where variations exist.

3.1 Schematic

Figure 3–1 shows the DM2013H schematic diagram.

Figure 3–1. DM2013H Schematic
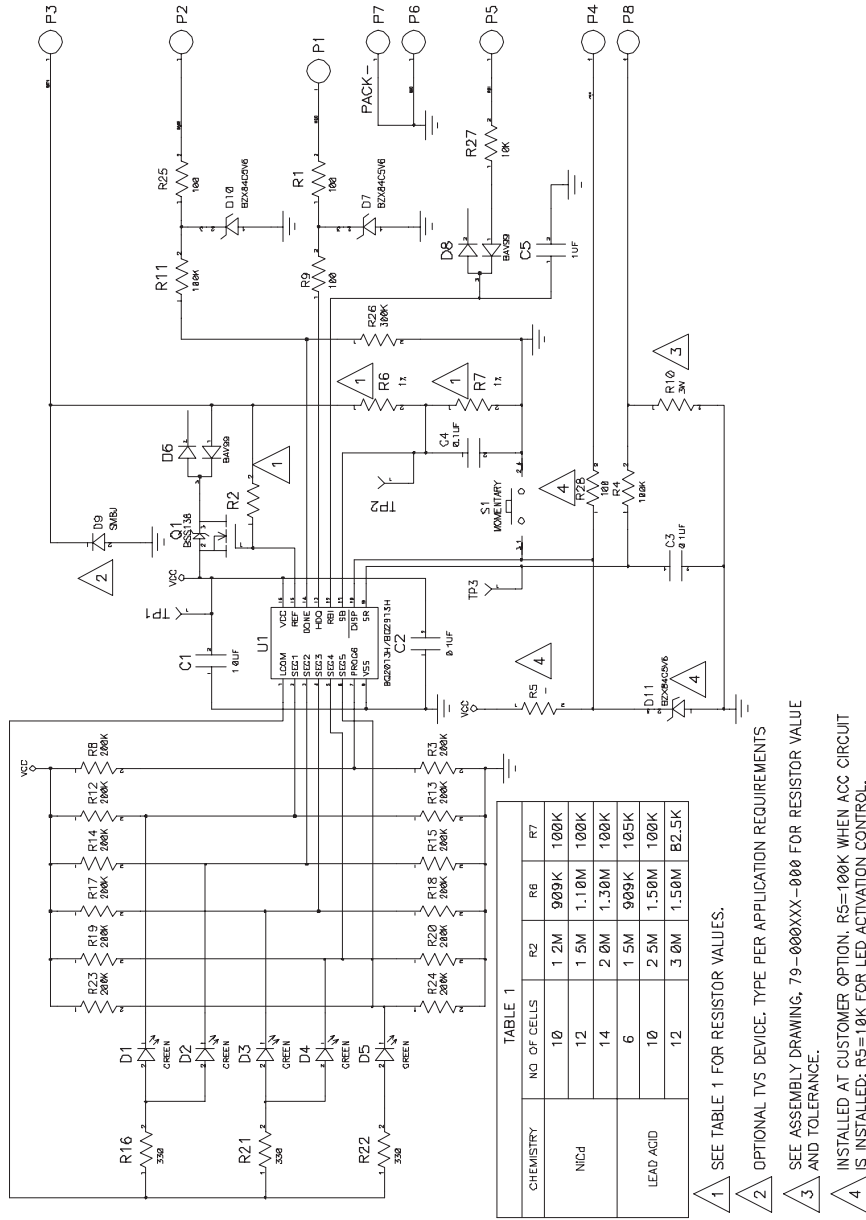
DM2013H Physical Layouts

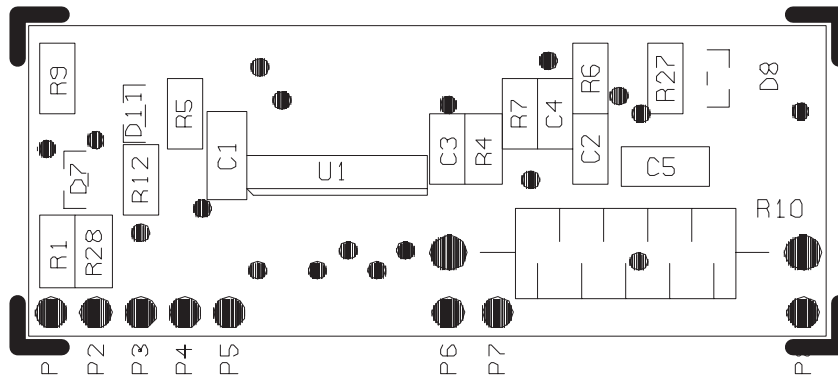This chapter contains the board layout and assembly drawings for the DM2013H.

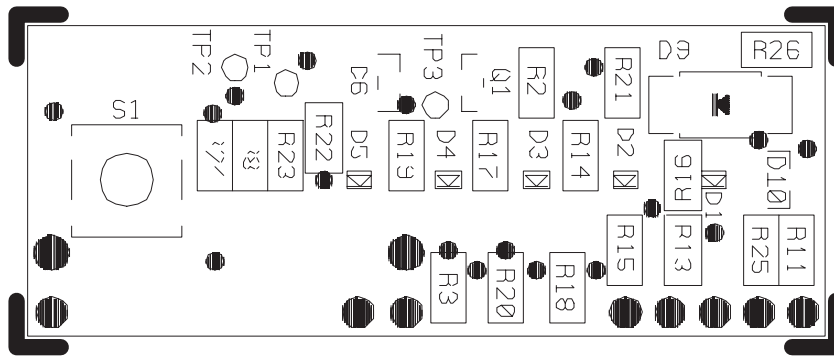## 4.1 Board Layout

Figure 4–1 shows the dimensions, PCB layers, and assembly drawing for the DM2013H.

Figure 4–1. DM2013H Dimensions and Layout

DM2013H Bill of Materials

This chapter contains the bill of materials required for the DM2013H.

5.1 Bill of Materials

Table 5–1 lists materials requdred for the DM2013H.

Table 5–1. Bill of Materials

Ref Des	Qty –001	Description	MFG	MFG PART#	Size
PCB	1	Printed Circuit Board, 0.031, FR4, SMOBC, HASL	Any	bq2113 REV.A	See FAB DWG
C1,C5	2	Capacitor, Ceramic, 1 µF, 25 V, ±20%, X7R	Panasonic	ECJ–3YB1E105K	3216
C2,C3,C4	3	Capacitor, Ceramic, 0.1 µF, 25 V, ±20%, X7R	Venkel	C0805X7R250–104MNE	2012
R1,R9,R25,R28	4	Resistor, 100 Ω, 1/10 W, 5%	Venkel	CR0805–10 W101JT	805
R2	1	Resistor, 1.5 MΩ, 1/10 W, 1%	Venkel	CR0805–10 W1504FT	805
R3, R8, R12, R13, R14, R15, R17, R18, R19, R20, R23,R24		NOT USED			805
R4,R5,R11	3	Resistor, 100 KΩ, 1/10 W, 5%	Venkel	CR0805–10 W104JT	805
R6	1	Resistor, 1.1 MΩ, 1/10 W, 1%	Venkel	CR0805–10 W1104FT	805
R7	1	Resistor, 100 KΩ, 1/10 W, 1%	Venkel	CR0805–10 W1003FT	805
R10†	1	Resistor, 0.010 Ω, 3 W, 1%, LVR–3, AXIAL	Dale	LVR–3 R010 1%	3 W, TH
R16,R21,R22	3	Resistor, 330 Ω, 1/10 W, 5%	Venkel	CR0805–10 W331JT	805
R26	1	Resistor, 300 KΩ, 1/10 W, 5%	Venkel	CR0805–10 W304JT	805
R27	1	Resistor, 10 KΩ, 1/10 W, 5%	Venkel	CR0805–10 W103JT	805
D1,D2,D3,D4,D5	5	LED, green, S Type	Panasonic	LN1371G–(TR)	
D6,D8	2	Diode,dual series switching, SOT–23	Zetex	BAV99	SOT–23
D7,D10,D11	3	Diode, Zener, 5.6V , .30 W, (BZX84C5V6), SOT–23	Motorola	BZX84C5V6	SOT–23
D9	1	Diode, TVS, 33 V, 600 W	Diodes Inc.	SMBJ26A	SMBJ
Q1	1	Transistor, MOSFET N–Ch	Zetex	BSS138	SOT–23
S1	1	Switch, Momentary, N.O., 5mmx1.5mm thk.	Panasonic	EVQ–PLHA15	5 mm

† Included, but not installed on board.

DM2013H Performance Specification Summary

This chapter summarizes the performance specifications of the DM2013H. Table 6–1 gives the performance specifications of the circuit.

Figure 6–1. Performance Specification Summary

Specification	Min	Typ	Max	Units
Charge and Discharge Current	0.05		15	A

Note: Charge and discharge maximums are limited by the power dissipation of the 10 mΩ 3 W sense resistor included in the kit.

EVM Hardware and Software Setup

This section describes how to install the bq2013H EVM PC software and how to connect the different components of the EVM.

7.1 Software Installation

The following steps install the EV2200–HDQ software:

1) Insert disk 1 into a 3 1/2 inch floppy drive.

2) Select the 3 1/2 inch drive using My Computer or File Manager.

3) Double-click the Setup.exe icon.

The setup program prompts for the remaining disks and installs a Windows application group.
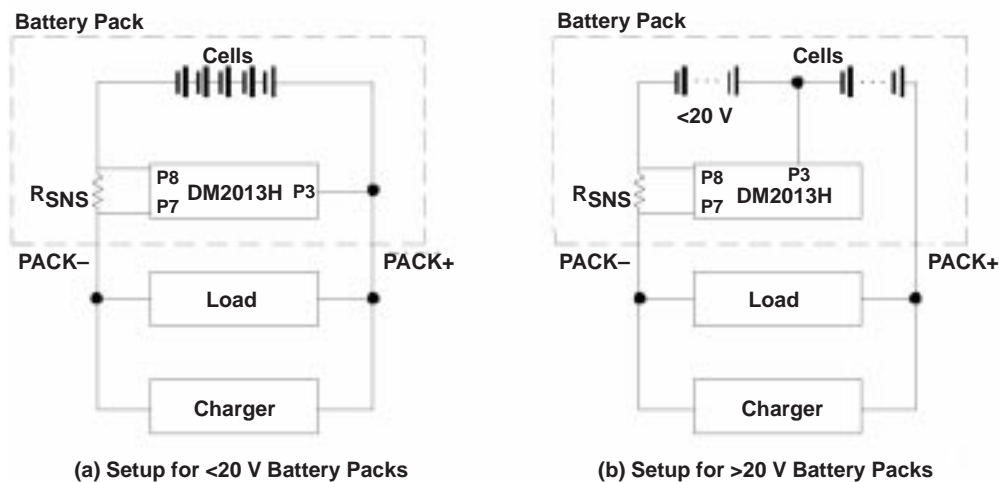
7.2 Hardware Connection

There are three hardware components to the bq2013H EVM: The DM2013H circuit module, the EV2200 PC interface board, and the PC.

7.2.1 Connecting the DM2013H to a Battery Pack

Figure 7–1 shows how to connect the DM2013H to a stack of cells, the sense resistor, and the system load/charger.

Figure 7–1. DM2013H Connection to Cells, Sense Resistor, and System Load/Charger

(a) Setup for <20 V Battery Packs   (b) Setup for >20 V Battery Packs

7.2.2   PC Interface Connection

The following steps configure the hardware for interface to the PC:

1) Connect the DM2013H based smart battery to the EV2200 using wire leads as in Table 7–1.

2) Connect the PC serial cable to the EV2200 and the PC COM port.

Table 7–1. DM2013H-to-EV2200 Connection

DM2013H Based Battery	EV2200
P1/HDQ	SMBD/HDQ1 or SMBC/HDQ2
P7/PACK–	VSS

The bq2013H EVM is now set up for operation.

Chapter 8

Operation

This chapter details the operation of the bq2013H EVM software.

8.1 Starting the Program

Run EV2200-xxH from the Start|Programs|EV2200-xxH menu sequence. The software requests the PC communications port the first time it is run after installation. Choose the Retry Auto-detection button for automatic port configuration. After the port is detected, the software displays the bq2013H data screen.

Figure 8–1. Initial Data Screen
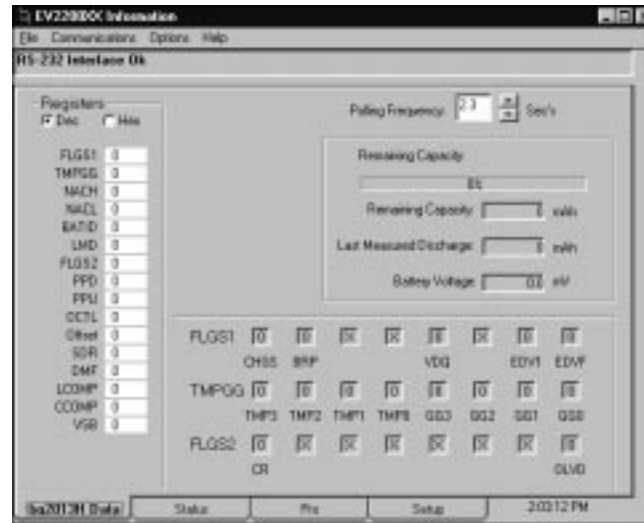
The data screen may not show correct information until parameters in the software are initialized.

8.2 Initialization

This section describes the settings that must be made before the EVM software can properly display data.

8.2.1 Device Program Settings

Select the bq2013H option from the Options|Device Selection pulldown menu. This sets the software to operate with the bq2013H. The program may prompt to quit and restart the program. If so, follow the on-screen instructions and restart the program. Once restarted, the software should be set up to work with the bq2013H.

8.2.2 HDQ Port

Note whether the HDQ line from the DM2013H is connected to SMBD/HDQ1 or SMBC/HDQ2 of the EV2200. Select HDQ1 for the SMBD/HDQ1 connection or HDQ2 for the SMBC/HDQ2 connection from the Options|HDQ pulldown menu.

8.2.3 Setup Parameters

Select the Setup tab.

Figure 8–2. Setup Screen

Enter the corresponding resistor values in the Circuit Configuration box. These values can be saved to disk using the Save Setup to Disk button so that they are automatically called up when the program loads.

Table 8–1. Resistor Designations for Setup Screen Input

Circuit Configuration NAME	Schematic Identifier
Rsns	R10–10 mΩ
RB1	R6
RB2	R7

The Initial Settings box programs selected registers of the bq2013H. The value can be entered in the selected box and written to the device by depressing the Write Settings to Device button.

The screen also displays how pins 2 (Prog1) through 7 (Prog6) are programmed. The Reset Device button initializes the bq2013H with the programmed settings.

The Table Data box interprets the programming for self-discharge, display mode, offset, and charge compensation. It also shows the programmed full battery capacity in terms of mVh and mAh (mAh = mVh/Rsns). The programmed full capacity or count (PFC) is set by the programming of pins 2–3.

8.3 Data Screen

After the setup parameters are entered, return to the bq2013H data screen to see the bq2013H registers. The screen displays the names and values of all the accessible registers of the bq2013H. The values can be displayed in hexadecimal or decimal. The Polling Frequency box sets the data polling rate of the data fields.

Figure 8–3. bq2013H Data Screen
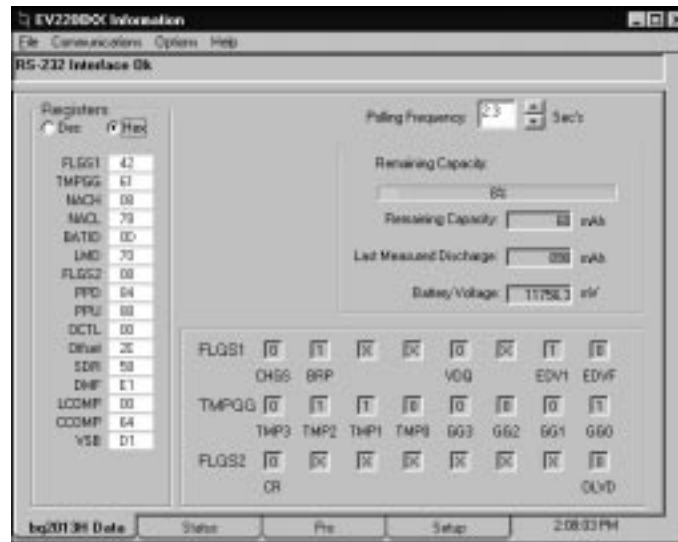
The registers can be written by selecting a data box, overwriting the present value with the desired value, and pressing ENTER. The data must be entered in the same base (decimal or hexadecimal) as the selected base. The screen also shows the bit status of the status flags registers FLGS1 and FLGS2.

8.4 Status Screen

The Status screen graphically illustrates bq2013H operation. The program shows the average current activity as well as the temperature and remaining capacity of the battery under evaluation.
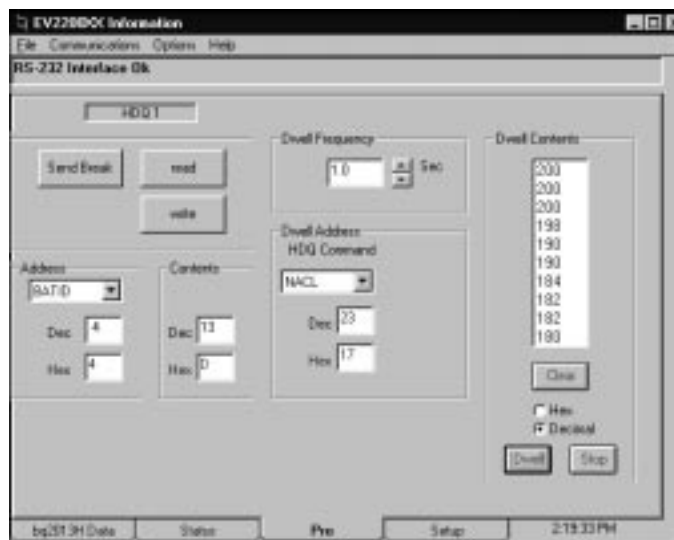
Figure 8–4. Status Screen
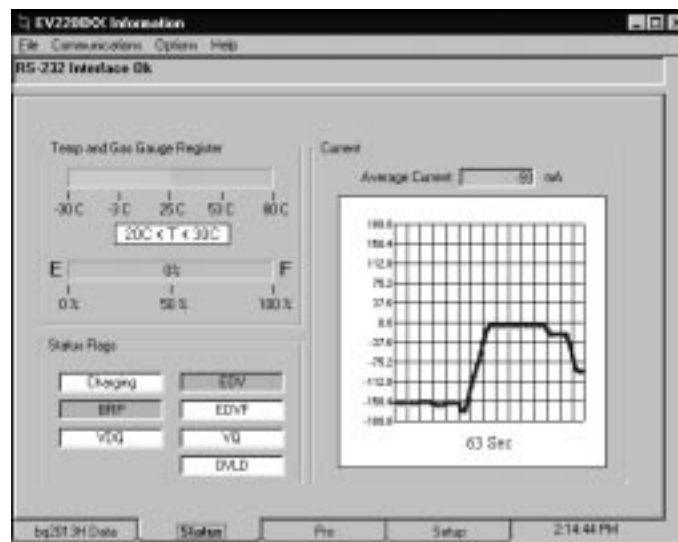
8.5   Pro Screen

The Pro screen allows read and write access to all the registers of the bq2013H.

Figure 8–5. Pro Screen

To read or write a location:

❏   Enter the address location of the register in the Address box. The register and address can be selected from the pulldown menu.

❏   Enter the data to be written if applicable.

❏   Depress the Read or Write button.

The Send Break button sends a communication timing reset signal to the bq2013H and should be depressed each time a bq2013H based batter is connected to the EV2200.

The program can continuously read a single address by using the dwell feature. To use the dwell feature:

❏   Enter the address to read in the Dwell Address box. This can be selected with the pulldown menu.

❏   Set the dwell frequency in the Dwell Frequency box.

❏   Click the Dwell button in the Dwell Contents box.

The contents of the register will start to scroll at the selected frequency.

8.6 Data Logging

The bq2013H registers can be logged by using the data log function. To log the data and create a log file:

❑ Select File|Start Data Log from the pulldown menu.

❑ Enter a data log file name

❑ Press OK

❑ Set the data log interval

❑ Press Close

❑ To stop the data logging select File|Close Data Log from the pulldown menu.

The file can be imported into a text editor, spreadsheet, or word processor program.